

**Wisconsin Highway Research Program
Request for Proposal for**

Laboratory Study of Optimized Concrete Pavement Mixtures

**Questions regarding the content of this RFP are due no later than
5PM (CDT), Monday, December 5, 2011**

**Responses to questions will be posted to the WisDOT Research and Library website
(<http://wisdotresearch.wi.gov/rfps-and-proposals>) by Monday, December 12, 2011**

**Proposals are due
5 PM (CST), Friday, January 13, 2012**

**For further information regarding this RFP
contact Andrew Hanz
at (608) 262-3835
E-mail: ajhanz@wisc.edu**

Monday, November 21, 2011

Researcher Proposal Preparation Guidelines

WHRP Proposal Guidelines are available on the WisDOT Research and Library website
(<http://wisdotresearch.wi.gov/wp-content/uploads/WisDOT-Policy-Research-proposal-guidelines-master.pdf>). Please refer to these instructions in preparation of your response.

I. Background and Problem Statement

The Wisconsin Department of Transportation (WisDOT) continues to investigate the feasibility of specifying lower required cementitious materials contents in paving mixtures as a means to improve engineering properties, reduce cost, and minimize environmental impacts. Previous research conducted by WisDOT has concluded that mixes produced with lower cementitious materials content increases the durability of the mix. However, these mixes frequently demonstrated poor workability. As a result, a multi-faceted approach to optimizing mixture proportioning for low-slump mixtures used in concrete pavements is needed for WisDOT to realize the benefits related to use of lower cementitious materials contents. This approach includes use of supplementary cementitious materials (SCM's), optimized aggregate gradation and use of super plasticizers. Current WisDOT practice minimizes the use of Portland Cement through replacement with supplementary cementitious materials (SCM's), but does not address the use optimized gradation or superplasticizers. Therefore, additional research is needed to support development of specifications inclusive of all the aforementioned factors to improve the performance and sustainability of concrete paving mixtures used in Wisconsin.

II. Objectives

The objective of this study is to produce guidelines for optimized concrete mix design through evaluation of a range of concrete mixture proportions on the basis of both workability and in-place performance. Based on the results the research will recommend aggregate gradation thresholds and superplasticizer concentrations that will accommodate the use of reduced cementitious materials for the low-slump concrete paving mixtures in the field.

III. Scope of Work

Proposal:

In the initial project proposal, the research team will be expected to define their draft experimental design and explain the rationale for this design. In the experimental design, the research team will also state the total number of different PCC mixtures that will be tested within the defined budget for this study.

Task 1: Literature Review

Synthesize relevant publications, research reports, guidance documents, and practices of other states related to use of optimized gradation, supplemental cementitious materials, and super plasticizers in concrete mix design.

Task 2: Development of Experimental Plan and Materials Selection

- a. Researcher shall develop a detailed final testing matrix in Task 2 for the prescribed testing for the spectrum of experimental mixture proportions against the required cross section of aggregates and cementitious materials.

- i. Aggregate Gradation: Final aggregate gradations utilized in the mixtures shall be optimized.
- ii. Researcher shall perform preliminary testing to minimize the use of chemical and mineral admixtures before the production of concrete.
- b. Final selection of aggregate sources shall be performed in consultation with WisDOT staff. The research team will be responsible for all aspects of materials procurement and transportation from the sources to their laboratory.

Task 3: Execution of Work Plan

Includes the mixing of concrete, fabrication of test samples, and measurement and documentation of concrete properties in the required testing matrix.

Task 4: Data Analysis, Summary, and Reporting

Includes analysis and summary of all test data, and preparation of the draft final report.

Final Project Deliverables

- a. Deliver draft final report: The draft final report will summarize the development of the experimental plan and test results. Conclusions and recommendations will specifically address WisDOT efforts to implement the use of optimized concrete mix designs.
- b. Deliver project closeout presentation: The researcher will present research results to the Rigid Pavements Technical Oversight Committee (TOC).
- c. Revise draft final report based on TOC comments and submit final report to WHP. One electronic copy and 15 hard copies of the report are required.

IV. Required Concrete Properties to be Included in Test Matrix:

- a. Fresh Concrete Properties: The following fresh concrete properties shall be measured per the cited specification procedures during lab batching:
 - i) Slump (AASHTO T119) – 1/batch
 - ii) Air Content (AASHTO T152) – 1/batch
 - iii) Unit Weight (AASHTO T121) – 1/batch
- b. Hardened Concrete Properties: The following hardened concrete properties shall be determined per the cited specification procedures:
 - i) Compressive Strength (AASHTO T22) 8 - 6"x12" cylinders/batch (test 2 each at 3, 7, 28 and 90 days)
 - ii) Flexural Strength (AASHTO T97) 8 - 6"x6" prisms/batch (test 2 each at 3, 7, 28 and 90 days)
 - iii) Resistance of Concrete to Chloride Ion Penetration (AASHTO T259) 2 specimens sawed from single cylinder (wet cure and test at 28 days and 90 days)
 - iv) Resistance of concrete to Rapid Freezing and Thawing (AASHTO T161) 3 prisms per batch (300 cycles in 5% NaCl solution – moist cure for 28 days then air cure 28 days)

- v) Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete (ASTM C157)

V. Materials Requirements:

All materials for concrete mixtures shall meet requirements of WisDOT Standard Specifications, except as modified below.

a. Aggregate Requirements

- i. All aggregate sources shall have a record of passing WisDOT HPC aggregate quality tests (LA Wear = 35% max, Sodium Soundness = 6% max) Use of northern and southern aggregates required as noted below*
- ii. Coarse aggregate shall have 1-1/2" nominal top size

b. Cementitious Materials Requirements

- i. The Portland cement used shall include 3 sources with different chemistry commonly used for PCC paving in WI (suggested sources are Lafarge-Alpena, MI; St Marys-Charlevoix, MI; and Holcim-St Genevieve, MO)
- ii. Principal cementitious materials content should be 470 lbs/cy.
- iii. Fly ash shall include **Class F** and Class C with different chemistry.
- iv. Slag source – GGBFS Grade 100 and Grade 120

c. Chemical Admixtures

- i. High Range Water Reducers – Polycarboxylate and Naphthalene based superplasticizers that meet ASTM C494 Type F requirements
- ii. A standard dosage of low range water reducer shall be included in each batch.
- iii. A standard polyolefin type air agent shall be used in all batches.

d. Fresh Concrete Properties

- i. Air content shall be 6% (+/-1.0%) for each batch.
- ii. Slump shall be 1.5 inches (+/-1 inch).

*Northern coarse aggregate type shall be a typical northern WI glacial gravel. Southern coarse aggregate shall be a crushed limestone. Two sources of natural fine aggregate should be selected to compliment the coarse aggregate types. This would include a typical northern sand (principally igneous/metamorphic material) and a southern sand (with higher carbonate content).

VI. WisDOT/TOC Contribution:

- a. Expected Level of Contribution by WisDOT/TOC Members: Technical Oversight Committee will consult with research team in final selection of aggregate sources, monitor project progress, and provide review of draft final report.
- b. WisDOT Equipment: Researchers should not assume availability of WisDOT equipment in the proposal. If equipment is donated to the project by WisDOT or another entity, a letter of commitment must be included in the proposal.

VII. Other Project Requirements

- a. Laboratory/Technician Certifications: The following certifications from the WisDOT Highway Technician Certification Program (HTCP) are required for this project:
 - i) Aggregate Technician (AGGTEC 1)
 - ii) Portland Cement Concrete Technician (PCCTEC 1)
 - iii) Concrete Strength Tester CST
- b. Travel: Researcher is responsible for travel related to collection of materials and attendance at a minimum of one TOC meeting.

VIII. Budget and Time Frame

- a) Project Duration
 - i) The total duration of the project is 30 months with an anticipated start date of August 1, 2012.
 - ii) The draft final report shall be submitted at least three months prior to contract end date.
 - iii) Contract is considered closed upon submission of electronic and hard copies of the final report.
- b) Project Budget
 - i) The project budget shall not exceed \$200,000 and shall include any costs associated with performing tests, analyzing the data and preparing the draft and final report.
- b) The researcher is expected to submit the draft final report with quality technical writing and proper grammar. It is acceptable to include a technical editor on the research team to ensure these requirements are met.
- c) Matching funds will not be considered in the proposal evaluation process.

IX. Implementation

- a) This study will develop recommended values for concrete properties to be used by the Department in the MEPDG pavement design process; it will recommend design criteria for optimized, plasticized, low slump paving concrete at a reduced cementitious content that meets the expected design parameters.
- b) Researcher is expected to communicate the following:
 - i) Recommended potential changes in practice.
 - ii) Benefits in terms of performance and cost savings.